CLAIMS

1. A method for evaluating the tuning of a target parameter of a target component in a charged particle beam system, wherein a charged particle beam is transported through said target component, comprising the steps of:

(a) varying a control parameter of a control component located upstream of the target component, wherein said control parameter has a predetermined relation to said control component;

(b) measuring beam current downstream of said target component in said charged particle beam system as said control parameter is varied; and

(c) evaluating the tuning of said target parameter based on the beam current measurements and the predetermined relation between the target component and the control parameter.

2. A method as defined in claim 1, wherein the step of evaluating the tuning of said target parameter comprises determining whether the beam current is at least a predetermined fraction of the maximum observed beam current when said control parameter is at its initial value.

3. A method as defined in claim 2, further comprising the step of performing two or more iterations of all steps until a predetermined voting criteria is reached.

4. A method as defined in claim 3, where said predetermined voting criteria comprises the beam current exceeding a predetermined fraction of the maximum observed beam current, in at least a predetermined number of iterations.

5. A method as defined in claim 1, wherein the step of evaluating the tuning of said target parameter comprises determining whether maximum beam current is measured when said control parameter is offset above or below its initial value.

6. A method as defined in claim 1, wherein the step of evaluating the tuning of said target parameter comprises determining whether said target parameter is tuned to a higher or lower value than would result in maximum beam current measured downstream

from said target parameter, based upon the beam current measurements and the predetermined relation between said target component and said control parameter.

7. A method as defined in claim 1, further comprising the step of adjusting said target parameter based upon the evaluation of the tuning of said target parameter.

8. A method as defined in claim 7, further comprising the step of performing two or more iterations of all steps until the measured beam current meets a predetermined criteria.

9. A method as defined in claim 8, wherein the variation of said control parameter is smaller in magnitude during an iteration than in a preceding iteration.

10. A method as defined in claim 8, wherein said predetermined criteria constitutes the beam current being at least a predetermined fraction of the maximum observed beam current when said control parameter is at its initial value.

11. A method as defined in claim 7, wherein the step of adjusting said target parameter comprises analyzing the beam current measurements to determine a target parameter adjustment and adjusting said target parameter by the determined target parameter adjustment.

12. A method as defined in claim 11, wherein the step of analyzing the beam current measurements comprises determining a target parameter adjustment direction and magnitude to shift a peak beam current toward a required value of said control parameter.

13. A method as defined in claim 1, wherein said target component comprises a magnet which generates a magnetic field in response to a current, and wherein said target parameter comprises the approximate current supplied to said magnet.

14. A method as defined in claim 13, wherein the control component comprises an electrostatic component which generates an electric field in response to a control voltage and wherein the step of varying the control parameter comprises varying the control voltage.

15. A method as defined in claim 13, wherein said control parameter comprises the approximate entry angle of the charged particle beam into said magnet.

16. A method as defined in claim 13, wherein said control parameter comprises the approximate entry velocity of the charged particle beam into said magnet.

17. A method as defined in claim 13, wherein said target component comprises a bending magnet of a mass analyzer.

18. A method as defined in claim 13, wherein said target component comprises a charge state resolving magnet.

19. A method as defined in claim 13, wherein said target component comprises a parallelizing magnet for converting trajectories of said beam into substantially parallel trajectories.

20. A method as defined in claim 1, wherein said target component comprises an electrostatic component which generates an electric field in response to a voltage, and wherein said target parameter comprises the approximate voltage applied to said electrostatic component.

21. A method as defined in claim 1, wherein said control parameter comprises the approximate value of a power supply output feeding said control component.

22. A method as defined in claim 21, further comprising the step of measuring the value of said power supply output during the variation of said control parameter.

23. A method as defined in claim 22, further comprising the step of determining a secondary value of said power supply, within the range of values bounded by the extreme members of a set comprising at least one measurement of said control parameter readback

recorded nearly simultaneously with at least one measurement of said beam current at least a predetermined fraction of the peak observed beam current.

24. A method as defined in claim 23, further comprising the steps of reading a nominal control parameter readback value prior to initiating the variation of said control parameter; and adjusting said target parameter from its initial value by a predetermined function of the signed difference between said secondary value of said power supply and said nominal control parameter readback value.

25. A method as defined in claim 1, wherein the step of varying said control parameter comprises modulating the control parameter with a periodic waveform.

26. A method as defined in claim 1, wherein the step of varying said control parameter comprises stepping the control parameter through a predetermined pattern of discrete values.

27. A method as defined in claim 1, wherein said control parameter comprises the approximate value of a power supply output feeding said control component.

28. A method as defined in claim 27, wherein the step of varying said control parameter comprises stepping the control parameter through a predetermined pattern of discrete values more rapidly than said power supply output can stabilize in response to each setting.

29. A method as defined in claim 1, wherein the step of measuring beam current comprises measuring beam current with a Faraday beam sensor located downstream of said target component.

30. A method as defined in claim 1, wherein the step of measuring beam current comprises measuring beam current with a parametric current transformer located downstream of said target component.

31. A method as defined in claim 1, wherein the step of measuring beam current comprises measuring beam current samples for different values of said control parameter.

32. A method as defined in claim 1, further comprising the step of restoring said control parameter to its initial value.

33. A method as defined in claim 1, wherein said control parameter responds to adjustment more rapidly than said target component responds to adjustment.

34. A method as defined in claim 1, wherein the step of evaluating said target parameter comprises performing a Fourier analysis on the waveform of the measured beam current.

35. A method as defined in claim 1, wherein said charged particle beam system comprises an ion implanter.

36. A method as defined in claim 1, wherein said charged particle beam system comprises a particle accelerator.

37. A method as defined in claim 1, wherein said charged particle beam system comprises a mass spectrometer.

38. A method for tuning a target parameter of a target component in a charged particle beam system, wherein a charged particle beam is transported through said target component, comprising the steps of:

(a) determining a nominal target parameter value;

(b) measuring a nominal readback value of said target parameter;

(c) varying said target parameter in a predetermined pattern about said nominal target parameter value;

(d) measuring the beam current downstream of said target component in said charged particle beam system, and the target parameter readback value of said power supply output, as said target parameter is varied;

(e) determining an optimal readback value, within the range of values bounded by the extreme members of a set comprising at least one measurement of said target parameter readback value recorded nearly simultaneously with at least one measurement of said beam current at least a predetermined fraction of the peak observed beam current;

(f) adjusting the nominal target parameter value by a predetermined function of the signed difference between said nominal readback value and said optimal readback value; and

(g) performing two or more iterations of at least steps (b), (c), (d) and (e) until said beam current measurements meet a predetermined criteria.

39. A method as defined in claim 38, wherein the variation of said target parameter is equal or smaller in magnitude during an iteration than in a preceding iteration.

40. A method as defined in claim 38, wherein said predetermined criteria constitutes beam current being at least a predetermined fraction of the maximum observed beam current when the absolute difference between said optimal readback value and said nominal readback value is smaller in magnitude than a predetermined threshold.

41. A method as defined in claim 38, wherein said target component comprises an electrostatic component which generates an electric field in response to a voltage, and wherein said target parameter comprises the approximate voltage applied to said electrostatic component.

42. A method as defined in claim 38, wherein the step of varying said target parameter comprises modulating the target parameter with a periodic waveform.

43. A method as defined in claim 38, wherein the step of varying said target parameter comprises stepping the target parameter through a series of discrete values.

44. A method as defined in claim 38, wherein said target parameter comprises the approximate value of a power supply output feeding said target component.

45. A method as defined in claim 44, wherein the step of varying said target parameter comprises stepping the target parameter through a series of discrete values more rapidly than said power supply output can stabilize in response to each setting.

46. A method as defined in claim 38, wherein the step of measuring beam current comprises measuring beam current with a Faraday beam sensor located downstream of said target component.

47. A method as defined in claim 38, wherein the step of measuring beam current comprises measuring beam current with a parametric current transformer located downstream of said target component.

48. A method as defined in claim 38, wherein the step of measuring beam current comprises measuring beam current samples for different values of said target parameter.

49. A method as defined in claim 38, wherein the step of evaluating said target parameter comprises performing a Fourier analysis on the waveform of the measured beam current.

50. A method as defined in claim 38, wherein said charged particle beam system comprises an ion implanter.

51. A method as defined in claim 38, wherein said charged particle beam system comprises a particle accelerator.

52. A method as defined in claim 38, wherein said charged particle beam system comprises a mass spectrometer.

53. A method for evaluating the tuning of a target parameter of a target component in a charged particle beam system, wherein a charged particle beam is transported through said target component, and said target parameter determines the approximate downstream focus of said charged particle beam, comprising the steps of:

(a) determining a nominal target parameter value, wherein said target parameter determines the approximate position of said charged particle beam at the plane of a beam current sensing device located downstream from said target component within said charged particle beam system;

(b) varying said target parameter in a predetermined pattern about said nominal control parameter value, such that said charged particle beam is alternately incident on and not incident on said beam current sensing device;

(c) measuring beam current with said beam current sensing device, as said target parameter is varied;

(d) determining the sharpness of the transition between said charged particle beam being incident on and not incident on said beam current sensing device; and

(e) evaluating the tuning of said target parameter based at least in part on said sharpness.

54. A method as defined in claim 53, wherein the step of determining sharpness constitutes determining the derivative of beam current as a function of said target parameter as said charged particle beam is passed across an edge of said beam current sensing means.

55. A method as defined in claim 53, wherein the step of evaluating the tuning of said target parameter further comprises evaluating a predetermined function, taking as inputs at least said sharpness and the maximum observed beam current.

56. A method as defined in claim 53, comprising performing two or more iterations of at least steps (b), (c), (d) and (e) until the evaluated tuning of said target component meets a predetermined criteria.

57. A method as defined in claim 56, wherein the variation of said control parameter is equal or smaller in magnitude during an iteration than in a preceding iteration.

58. A method as defined in claim 56, wherein said predetermined criteria constitutes beam current being at least a predetermined fraction of the maximum observed

beam current when the absolute difference between said optimal readback value and said nominal readback value is smaller in magnitude than a predetermined threshold.

59. A method as defined in claim 53, wherein said target component comprises an electrostatic component which generates an electric field in response to a voltage, and wherein said target parameter comprises the approximate voltage applied to said electrostatic component.

60. A method as defined in claim 53, wherein the step of varying said target parameter comprises modulating the target parameter with a periodic waveform.

61. A method as defined in claim 53, wherein the step of varying said target parameter comprises stepping the target parameter through a series of discrete values.

62. A method as defined in claim 53, wherein the step of varying said target parameter comprises stepping the target parameter through a series of discrete values more rapidly than said target parameter can stabilize in response to each setting.

63. A method as defined in claim 53, wherein the step of measuring beam current comprises measuring beam current with a Faraday beam sensor located downstream of said target component.

64. A method as defined in claim 53, wherein the step of measuring beam current comprises measuring beam current with a parametric current transformer located downstream of said target component.

65. A method as defined in claim 53, wherein the step of measuring beam current comprises measuring beam current samples for different values of said target parameter.

66. A method as defined in claim 53, wherein said charged particle beam system comprises an ion implanter.

67. A method as defined in claim 53, wherein said charged particle beam system comprises a particle accelerator.

68. Apparatus for evaluating the tuning of a target parameter of a target component in a charged particle beam system, wherein a charged particle beam is transported through the target component, comprising:

means for varying a control parameter of a control component located upstream of the target component, wherein said control parameter has a predetermined relation to the target component;

means for measuring beam current downstream of the target component as the control parameter is varied; and

means for evaluating the tuning of the target parameter based on the beam current measurements and the predetermined relation between the target component and the control parameter.

69. Charged particle beam apparatus comprising:

a target component controlled by a target parameter;

a control component controlled by a control parameter and located upstream of the target component;

a beam sensor located downstream of the target component for sensing a charged particle beam transported through the control component and the target component; and

a controller for varying the control parameter and evaluating the tuning of the target parameter in response to beam current measurements received from the beam sensor, based on the predetermined relation between the target component and the control parameter.

70. A charged particle beam system comprising:

one or more beamline components through which a charged particle beam is transported;

a centralized controller for controlling the system; and

at least one localized controller containing a tuning algorithm for automatically tuning a selected one of said one or more beamline components in response to a tune command from said centralized controller.

71. A method for adjusting the focus of a charged particle beam, comprising the steps of:

(a) deflecting the charged particle beam across an edge of an aperture;

(b) determining the rate of change of beam current downstream of the aperture as the beam is deflected across the edge of the aperture;

(c) repeating steps (a) and (b) for different focus settings of the charged particle beam; and

(d) selecting the focus setting which gives the highest rate of change of beam current downstream of the aperture as the beam is deflected across the edge of the aperture.

72. In a charged particle beam system comprising a plurality of beamline components through which a charged particle beam is transported, a centralized controller and one or more power supply controllers for controlling individual ones of said beamline components, a tuning method comprising the steps of:

said centralized controller sending a tune command to a selected one of said power supply interfaces; and

the selected power supply controller automatically executing a tuning algorithm in response to the tune command.